350-269 XR 3553364

United States Patent

[11] 3,553,364

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[54] **ELECTROMECHANICAL LIGHT VALVE**
14 Claims, 16 Drawing Figs.

[52] U.S. Cl. 178/7.3, 350/269
[51] Int. Cl. H04n 5/74
[50] Field of Search 178/7.3D, 7.5D, 6A, 6LMS; 350/17, 266, 269, 160; 315/169TV

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ABSTRACT: An electromechanical light valve in an array of many such valves for controlling the transmission of light in continuously changing patterns. Each light valve consists of a housing having grounded conducted walls for shielding the interior thereof from external electrostatic forces produced by surrounding valves in the array or from other external forces. Light from a source enters one end of the housing through a light transparent and electrically insulating panel coated with a conductive film to which is mounted one or more electrostatically controlled leaf shutters. The leaf shutter and the conductive housing walls form a capacitor; connecting a voltage to the leaf shutter sets up a charge thereon thereby causing the shutter to be attracted to the housing walls. Voltages for charging the leaf shutters of all the valves in an array are generated by an XY scanner. A slight modification changes valve from a light transmissive device to a light reflective valve.

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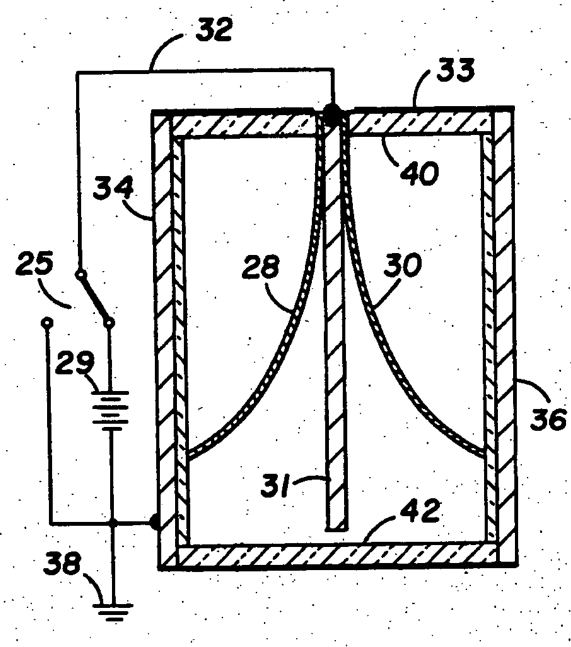

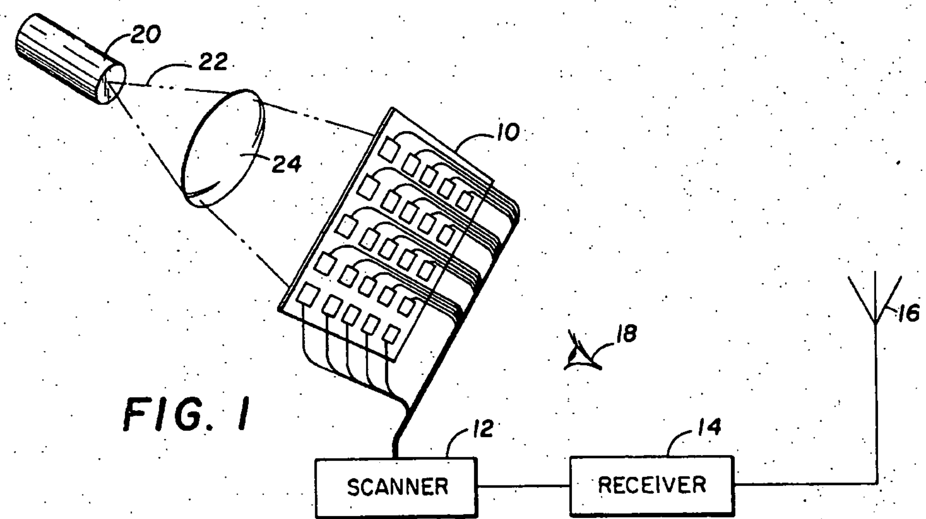

FIG. 1

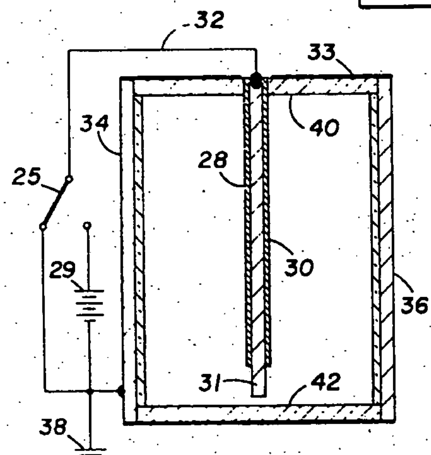

FIG. 3a

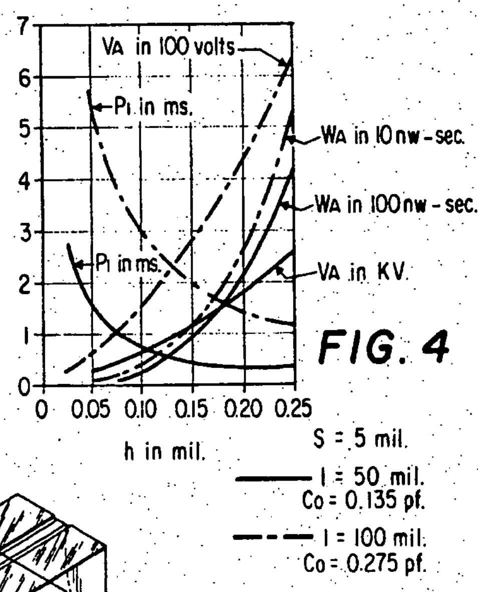

FIG. 4

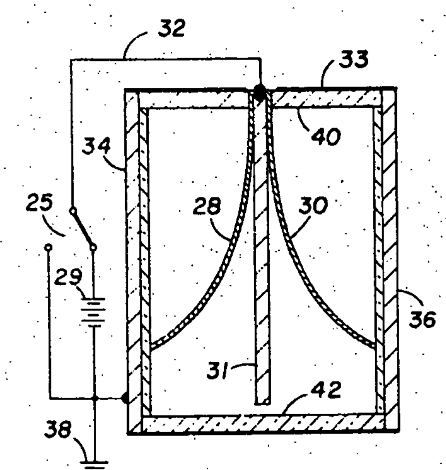

FIG. 3b

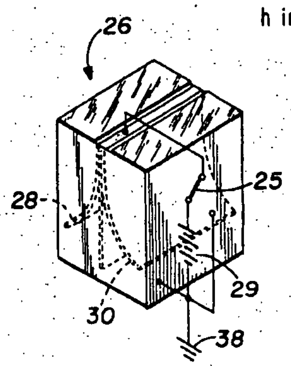

FIG. 2

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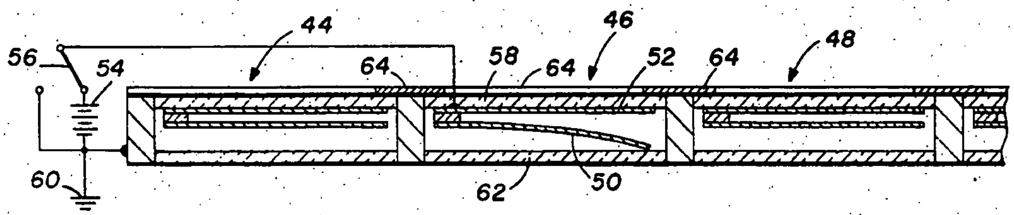

FIG. 5

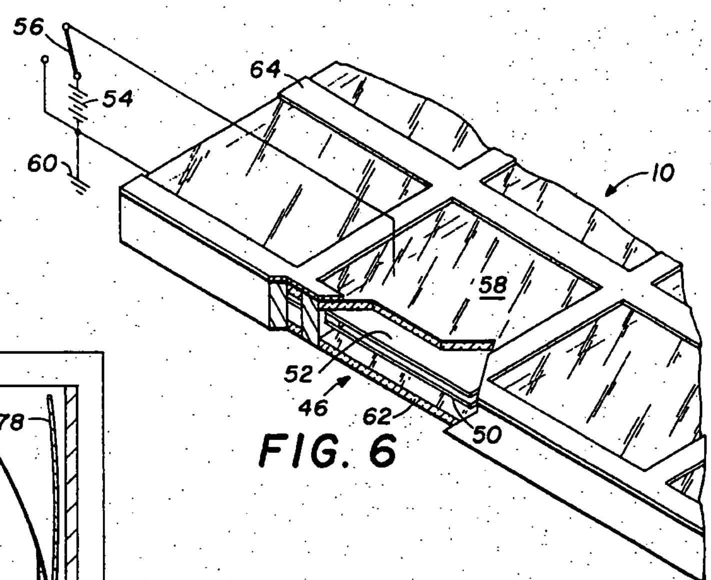

FIG. 6

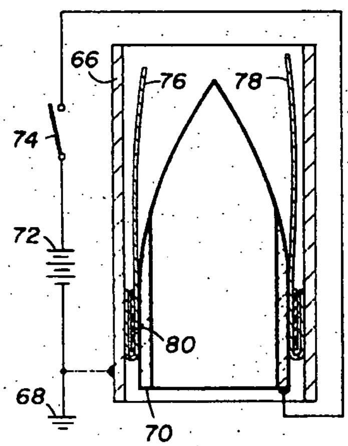

FIG. 7a

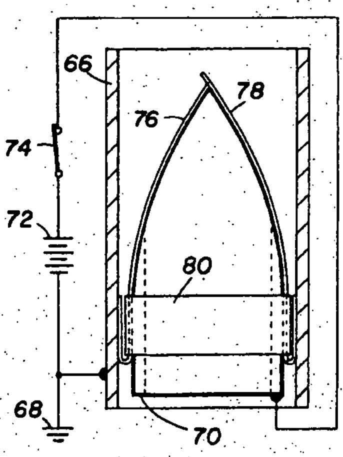

FIG. 7b

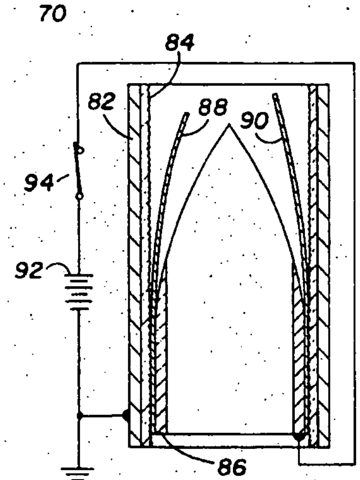

FIG. 8

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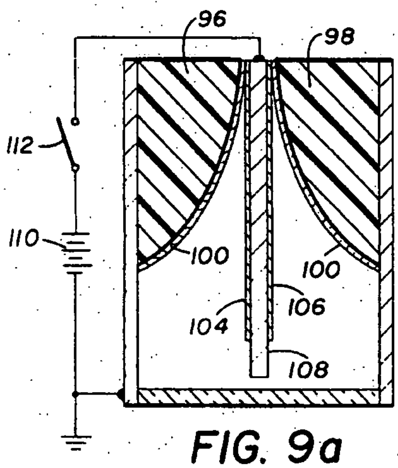

FIG. 9a

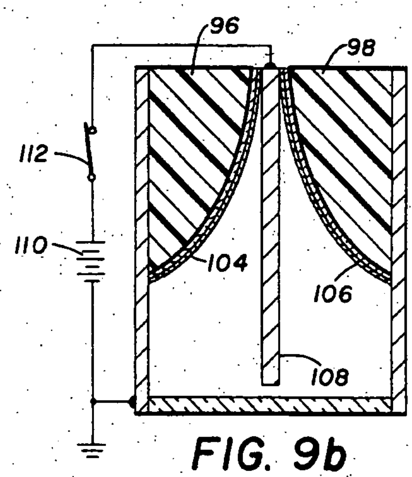

FIG. 9b

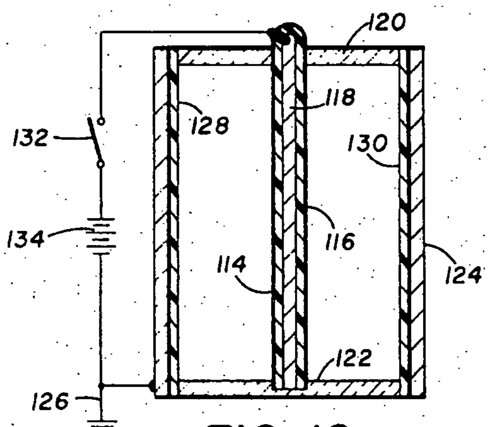

FIG. 10a

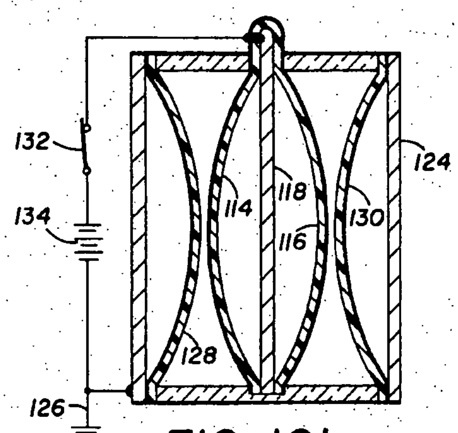

FIG. 10b

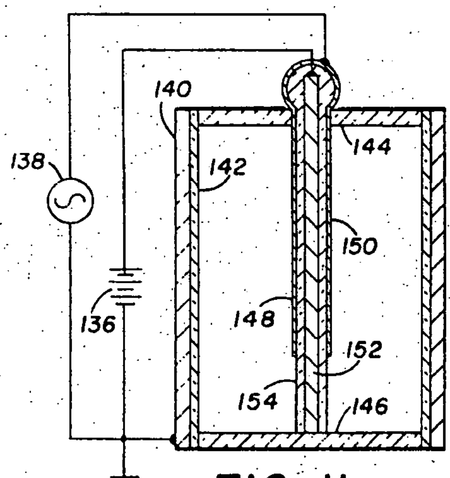

FIG. 11a

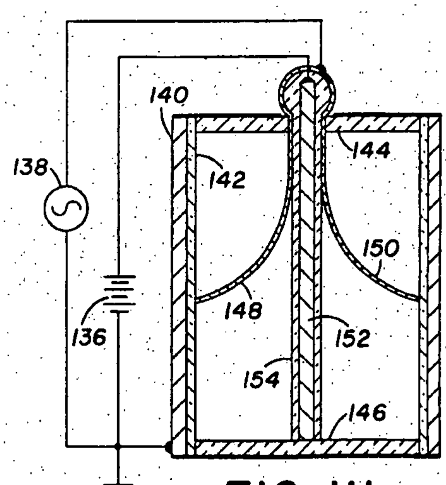

FIG. 11b

ELECTROMECHANICAL LIGHT VALVE

This invention relates to light transmission or light reflection control, and more particularly to a light valve for controlling the transmission or the reflection of light by means of an electrostatic charge.

During the early development of television in the latter part of the last century, a picture was generated on the retina of the eye of an observer by the rapid movement and intensity fluctuation of a narrow light beam. Because of persistence of vision of the human eye, a picture was in fact generated although of a very low quality. A method in vogue in panel displays, such as television, during the first part of the present century built up a picture by controlling the transmission of a high intensity light source by means of light valves. Two patents which issued about this time on light valves are U.S. Pat. No. 1,848,888 and U.S. Pat. No. 1,964,062. Both of these patents describe light valves reportedly operated by means of electrostatic forces generated on a shutter mechanism.

Earlier light valves such as described in the aforementioned patents are extremely inefficient because of the large amount of "crosstalk" or interference between adjacent valves. As a result, the displays produced by earlier light valves were not acceptable due to inferior picture resolution.

As a result of inferior picture quality, earlier efforts for producing a picture by means of light valves were abandoned in favor of its electron counterpart, the cathode ray tube. However, it is now realized that the cathode ray tube displays have their limitation especially when producing color pictures. Screen sizes larger than a 25-inch diagonal measurement produces a picture that lacks brightness as well as being difficult to handle (too bulky), and smaller than a 21-inch diagonal measurement suffers in resolution on account of tolerance requirements.

It is an object of this invention to provide a light valve isolated from surrounding electrostatically generated forces, thereby reducing "crosstalk."

A further object of this invention is to provide a light valve for a panel display.

Yet another object of this invention is to provide a light valve for a panel display using an ordinary light source.

A still further object of this invention is to provide a light valve operable from a low voltage source and consuming small amounts of power.

An additional object of this invention is to provide a light valve not affected by the earth's magnetic field.

Another object of this invention is to provide a light valve having a response time well within present standards established for television displays.

Still another object of this invention is to provide a light valve for large area display systems with acceptable brightness and resolution characteristics.

In accordance with a specific embodiment of this invention, an electromechanical light valve is provided for controlling the transmission of light from a source. The valve includes a housing having a grounded conductive wall for shielding the interior thereof from external electrostatic forces, and a light transparent panel at the light source end of the housing mounting an electrostatically controlled leaf shutter deflectable in the housing by means of an electrostatic charge thereon generated by an applied voltage.

In accordance with another embodiment of the invention, by properly arranging the light source direction with respect to the electrostatically controlled leaf shutter, the light valve produces a display by means of light reflection. This valve includes an electrostatically shielded housing, and an opaque panel supporting electrostatically controlled leaf shutters reflecting light piped into the housing from a light source.

A more complete understanding of the invention and its advantages will be apparent from the specification and claims and from the accompanying drawings illustrative of the invention.

Referring to the drawings:

FIG. 1 illustrates a picture receiving system employing a light valve panel in accordance with the present invention;

FIG. 2 is an enlarged view in perspective of a single light valve in the panel illustrated in FIG. 1;

FIGS. 3*a* and 3*b* are enlarged illustrations of the light valve of FIG. 2 showing the operation thereof;

FIG. 4 is a plot of response time in milliseconds, applied voltage in volts, and energy in nonowatt-seconds versus the thickness of a nonmagnetic stainless steel light valve shutter;

FIG. 5 is a cross section, partially cutaway, of the panel of FIG. 1 showing parallel leaf shutter valves;

FIG. 6 is a perspective view of the light panel of FIG. 5, partially cutaway, of the parallel leaf shutter valves;

FIGS. 7*a* and 7*b* show schematically a charged-dark light valve;

FIG. 8 is a modification of the valve of FIG. 7 for a charged-bright valve;

FIGS. 9*a* and 9*b* illustrate a modification of the valve shown in FIG. 2 for improving the response time of the leaf shutters;

FIGS. 10*a* and 10*b* illustrate a light valve using fixed-at-both-end leaf shutters; and

FIGS. 11*a* and 11*b* illustrate a two voltage source light valve.

Basically, the system illustrated in FIG. 1 consists of a light valve panel 10 and an address scanner 12. The address scanner 12 performs XY scanning of the panel 10 as well as intensity modulation (Z axis control) for each light valve of the panel array. Many XY scanners are available that produce a variable voltage for each XY position of an array. A video receiver 14 coupled to an antenna 16 controls the operation of the address scanner 12 in the usual manner of present day video receiving systems. To generate a visual display for an observer 18 on the panel 10, a light source 20 produces a light beam 22 collimated by a lens 24. A light panel may also be employed as a light source replacing the source 20 and the lens 24. This panel would match the size of the panel 10. By selectively opening and closing each light valve in the panel 10 in accordance with the video signal received by the antenna 16, the observer 18 sees a picture display.

Although this description will proceed to emphasize a television system, it is not intended to be so limited. The scanner 12 may be programmed from any one of many sources other than the receiver 14. For example, a computer can be employed to program the scanner 12 to produce simulated environmental conditions, such as might be encountered in space travel, to the observer 18.

In a typical television system in accordance with present day NTSC (National Television Systems Committee) regulations, the panel 10 includes 525 scanning lines, a bandwidth chosen for equal area resolution with an aspect ratio of 4:3, and there would be two interlaced fields in one frame having a frame rate of 30 frames per second. Accordingly, in order to fully utilize the NTSC information, the panel 10 has $525 \times (4/3 \times 525) = 367{,}500$ light units (one light valve per unit for a monochrome display, two light valves per unit for a bicolor display, and three light valves per unit for a tricolor display). In terms of light units, the video information received at the antenna 16 comes in at a rate of 0.0906 microseconds per unit (roughly 0.1 microsecond). Thus, for sequential addressing each valve in the panel 10 must be able to be addressed within 0.1 microsecond and be updated once per one-thirtieth second. However, other addressing schemes, such as line sequential addressing, may be used.

Referring to FIGS. 2 and 3, there is shown an electromechanical light valve 26 having two chargeable leaf shutters 28, 30 connected to a battery 29 through a two-position switch 25. Typically, the shutters 28 and 30 are made from a metallic material, such as copper, but other materials can be used as will be explained shortly. The light valve 26 includes a housing having sidewalls 34 and 36 along with front and back walls all of a reflective opaque material either electrically conductive, such as aluminum, or electrically insulating and covered with a conductive coating. An insulating layer, as shown in FIGS. 3*a* and 3*b*, covers the conductive coating to electrically insulate the housing walls from the shutters. The

housing or conductive coating is grounded by means of a lead 38 to provide electrostatic shielding, thereby eliminating electrostatic forces in the housing interior generated externally thereof. One of the many advantages of the light valve of this invention is that the housing need not be air sealed. Although sealing and evacuating may be desirable in some application, it is not a necessity as the valve operates in an air environment. At the light source end of the valve 26, the top shown in FIGS. 2 and 3, there is provided an electrically insulating mounting panel 40 for the shutters 28 and 30 and for an electrically conductive center plate 31. The panel 40 transmits light wave energy produced by the source 20 and is covered with a transparent electrically conductive film 33, except in the area of lead 32, connected to ground through the lead 38. At the observer's end of the valve 26, the bottom of FIGS. 2 and 3, there is a light transparent panel 42 having a light transmissive electrically conductive film deposited thereon (schematically illustrated by a heavy line) connected to ground through the lead 38. Thus, the shutters 28 and 30 are shielded to eliminate "crosstalk." Both the input panel 40 and the output panel 42 may have filtering properties to pass only selected wavelengths of the light beam 22. In addition, the output panel 42 may be processed to diffuse the light transmitted to expand the viewing area.

Operationally, the light valve 26 uses the well-known electroscope principle with each of the leaf shutters 28 and 30 considered one plate of a capacitor with its respective sidewalls 34 and 36 forming the second plate. For the configuration shown in FIGS. 2 and 3, the capacitor plates are rectangular having a length L and a width b. For purposes of this discussion, the leaf shutters 28 and 30 will be considered to have a uniform thickness h, a uniform modulus of elasticity (Young's modulus) E, and made from an elastic material of uniform density d. It will be understood that other shutter configurations are possible and materials with nonuniform properties may be used.

Neglecting edge effects, the capacitance of a deenergized valve is given by the equation:

$$C_o=0.2248KLb/s \qquad (1)$$

where K is the dielectric constant of the capacitor medium (unity for air) and s is the distance between the undeflected leaf shutter 28 and the sidewall 34. Considering only the leaf shutter 28 and its associated sidewall 34, these will be charged to $+Q_o$ and $-Q_o$, respectively, when a voltage of magnitude V_o is applied to the lead 32 in accordance with the equation $Q_o=C_oV_o$. This charge is uniformly distributed, neglecting edge effects, over the facing surfaces, resulting in a uniformly distributed load on the leaf shutter 28 and setting it in motion against both the inertia and elastic properties of the shutter material.

Since electrical charging is a surface phenomena, the shutters 28 and 30 are not restricted to metallic materials but cover the broad spectrum of all materials capable of storing a surface charge. This permits a wide choice of materials in regards to the electrical, mechanical, and optical characteristics.

To completely shut off the transmission of light to the observer 18, the leaf shutter 28 must be deflected to the sidewall 34. The voltage connected to the lead 32 to deflect the shutter 28 to the wall 34 is identified as the pull-in voltage, V_s. A conservative estimate of the pull-in voltage may be calculated from the equation:

$$V_s=8.185\times10^5(E/K)^{1/2}(s^3h^3)^{1/2}/L^2 \qquad (2)$$

where V_s is in volts. As a practical matter, the valve 26 is designed to meet given panel requirements and the pull-in voltage determined by actual measurement. The power required to deflect the leaf shutter 28 to the wall 34 can now be calculated from the expression:

$$W_s=7.56\times10^7Es^2h^3b/L^3 \qquad (3)$$

where W_s is given in nanowatt-seconds. Again the value given by equation (3) will be somewhat conservative estimate.

Referring to FIG. 4, there is shown two sets of curves calculated from the above equations illustrating the pull-in voltage, the pull-in energy, and the period of oscillation of the leaf shutters 28 and 30 in microseconds. The leaf shutters are separated from their respective walls by 5×10^{-3} inches in the undeflected condition. These curves are for nonmagnetic stainless steel shutters having a Young's modulus of 30×10^6 lbs./in.^{2}, a uniform density d of 0.283 lbs./in.3, a shutter width of 30 mils and operating in air with K equal to one. The solid line curves are for leaf shutters 50 mils long where the valve has a capacitance, C_o, of 0.135 pf. The dot-dash curves are for leaf shutters 100 mils in length and valves having a capacitance, C_o, of 0.275 pf.

The description to this point has emphasized a valve for controlling light transmission to produce an image display on the panel 10. By a slight modification, the valve 26 of FIGS. 2 and 3 produces an image display on the panel 10 by means of reflected light. The two chargeable leaf shutters 28 and 30 are made from a light reflective material, such as chrome plated beryllium copper, and mounted, as shown in FIG. 2, in a housing of an opaque material. In addition to being electrically conductive, the center plate 31 is now made of a material which also transmits light such as a fiber optic material. The lower end of the center plate 31, referring to FIG. 3a, not covered by the shutters 28 and 30 is made opaque. Also, the input panel 40 will be of an opaque material similar to the housing proper.

Light is piped into the valve housing by means of the light transmissive center plate 31 from the source 20. With the shutters 28 and 30 in a discharged condition, shown in FIG. 3a, light entering the center plate 31 will be blocked from being transmitted through the output panel 42. However, charging the shutters 28 and 30 such that they assume a position as shown in FIG. 3b, permits light to be reflected from the shutters through the output panel. Thus, to the observer 18 a minimum brightness will be observed with a valve operating as shown in FIG. 3a and a maximum brightness will be observed when the valve is operating as shown in FIG. 3b. Other than producing a charged-bright condition, that is, charging the leaf shutters 28 and 30 reflects light to the observer 18, the reflective light valve operates in a manner similar to the light transmissive valve.

Referring to FIGS. 5 and 6, there is shown a portion of the light panel 10 wherein light transmission valves are charged to produce a light condition. Where the light transmission valve 26 of FIGS. 2 and 3 is a charged-dark configuration, that is, charging the leaf shutters 28 and 30 cuts off light to the observer 18, the light valves 44, 46 and 48 of FIG. 5 are a charged-bright configuration. Operationally, the light valves 44, 46, and 48 are similar to the light valve 26. Referring specifically to the light valve 46, with the understanding that the valves 44 and 48 are similar, it includes a leaf shutter 50 of an electrically conductive and opaque material spaced from a fixed leaf 52 of an electrically conductive and light transmissive material, both of which are connected to a voltage source 54 through a two-position switch 56. With specific reference to FIG. 1, the voltage source 54 and switch 56 are part of the address scanner 12. The plate 52 and the leaf shutter 50 are fastened to an input panel 58 of an electrically insulating and light transmissive material. The panel 58 transmits light wave energy produced by the source 20; it is covered with a transparent electrically conductive film (again schematically illustrated by a heavy line) connected to ground through metal sidewalls and conductive films of adjoining units through a lead 60. Each of the light valves 44, 46 and 48 shares a common wall with the adjoining valve. These sidewalls are of an opaque material either electrically conductive or covered with a conductive coating. An output panel 62 covers the observer's side of the valves of FIGS. 5 and 6; it is coated with an optically transparent electrically conductive layer connected to ground through the lead 60. This conductive layer forms the second capacitor plate as previously described with reference to FIGS. 2 and 3.

A video modulated voltage from the source **54** charges the leaf shutter **50** and the conductive surface of the panel **62** thereby generating a force on the shutter. This force causes the shutter **50** to be deflected to any "half-tone" position including in contact with the panel **62**. Half-tone positioning is the ability to control the shading of the image display. Light from the source **20** will now pass around the deflected shutter **50** and be transmitted to the observer **18**. A charge placed on the shutter **50** and the conductive surface of the panel **62** will remain until the two-position switch **56** connects the shutter to ground.

Because the shutter **50** cannot be made close fitting with the housing walls, a mask **64** extends over the input panel for each of the valves. This mask prevents light from being transmitted around the edge of the shutter **50** when in a noncharged condition.

Referring to FIGS. *7a* and *7b*, there is shown another configuration for a light valve of the panel **10**. A housing **66** of a reflective opaque material either electrically conductive or covered with a conductive coating is connected to ground through a lead **68**. In this configuration light is transmitted from the source **20** to the observer **18** through a hollow port **70** of an opaque electrically conductive material coated with an electrically insulating layer. Typically, the port **70** may be anodized aluminum. The hollow port **70** connects to a voltage source **72** through a switch **74**. A pair of leaf shutters **76** and **78** are attached to the port **70** by means of an elastic band **80**. The lower ends of the shutters are bent around the elastic band **80** to make electrical contact with the housing **66**. Thus, the shutters **76** and **78** are electrically connected to ground in the embodiment shown in FIGS. *7a* and *7b*. Closing the switch **74** causes an electrostatic charge to be built up in the port **70** and on the leaf shutters **76** and **78**. As a result, the shutters **76** and **78** are attracted to the port **70**, as shown in FIG. *7b*, to block out light from the source **20** to the observer **18**. Although not shown, input and output panels may enclose the end of the housing **66** to prevent dirt and other foreign matter from obstructing the operation of the valve and to provide electrostatic shielding for shutter isolation.

In a model of the valve shown in FIGS. *7a* and *7b*, the overall valve capacitance measured 30 picofarads. This is well below a limit which permits addressing (charging the capacitor plates) within 0.1 microsecond. The time required for the shutters **76** and **78** to close on the hollow port **70** after reaching a charged state was on the order of 8×10^{-3} seconds. The shutters **76** and **78** moved from a closed position to an open position, after being discharged, in about 3×10^{-3} seconds. Thus, as discussed previously, if a video display is updated once every 33 miliseconds, then about two-thirds of the display time is utilized to produce a picture. Since very strong light sources may be used, several orders of magnitude brighter than available phosphor displays, a sufficiently bright display will be produced even in bright ambient light conditions.

In FIG. **8** there is shown a modification of the valve of FIGS. *7a* and *7b* for charged-bright operation. The valve of FIG. **8** includes a housing **82** connected to ground and coated internally with an electrically insulating layer **84**. The hollow port **86** is of an electrically conductive material tied to a voltage source **92** through a switch **94**. Attached to the port **86** are leaf shutters **88** and **90**. Closing the switch **94** causes the leaf shutters **88** and **90** to be charged in one polarity and the housing **82** to be charged in the opposite polarity. The leaf shutters move away from the port **86** to the insulating layer **84**. As illustrated, the insulating layer **84** contains a series of grooves in the area of the leaf shutters **88** and **90**. These grooves provide air paths to minimize air drag between the insulating layer **84** and the leaf shutters when the switch **94** is closed thus enabling the shutter to operate in an air environment. Thus, as soon as the leaf shutters **88** and **90** are discharged, they begin to resume their normally biased position against the curved surfaces of the housing **86** to block off light from the source **20**. In general, unless air paths are provided to minimize air drag, the valve must be sealed and evacuated.

Referring to FIGS. *9a* and *9b*, there is shown another modification of the valve of FIG. **2** to improve the response time of the leaf shutters. A pair of light transmissive curved blocks **96** and **98** replace the input panel **40**. These blocks have a curved inner surface substantially conforming to the bending action of a cantilever beam. The curved surfaces of the blocks **96** and **98** are coated with a conductive layer (illustrated as a heavy line) and then covered with an optically transparent, electrically insulating layer **100**. In the light transmitting position, a pair of leaf shutters **104** and **106** are positioned against a center plate **108** all of which are connected to a voltage source **110** through a switch **112**. Closing the switch **112**, as shown in FIG. *9b*, causes the leaf shutters **104** and **106** to conform to the curved inner surfaces of the blocks **96** and **98**.

Consider the leaf shutter **104** to be a cantilever beam rigidly mounted at one end. This shutter has a certain moment of inertia which must be overcome before it begins to move from the center plate **108**. After the initial movement of the leaf shutter **104**, the cantilever length is shortened since the upper end is now in contact with the curved inner surface of the block **96**. This reduces the overall moment of inertia of the shutter and it begins to move faster to a fully light blocking position. Similarly, when the switch **112** is opened and the shutter **104** discharges, the shutter **104** opens first at the end with an increasing length thus improving the response time of the shutter over that if the block **96** were not used. Therefore, by including the blocks **96** and **98** in the valve of FIG. **2**, a faster responding valve results.

As mentioned previously, there is no limitation whereby the leaf shutters must be of a metallic material. Referring to FIGS. *10a* and *10b*, there is shown a light valve wherein the leaf shutters **114** and **116** are of a flexible plastic material covered with an electrically conductive coating. These shutters are positioned about a center plate **118** and fastened in place by means of an input panel **120** and an output panel **122**. The housing **124** is again of electrically conductive material connected to ground through a lead **126**. A second pair of flexible leaf shutters **128** and **130** are positioned between the outer edge of the input and output panels and the inner wall of the housing **124**. These shutters are also coated with an electrically conductive coating. Note that the electrically conductive coating of the shutters **128** and **130** is in contact with the housing **124**.

Closing a switch **132** connects a voltage source **134** to the shutters **114** and **116**, thereby positively charging shutters **114** and **116** and negatively charging shutters **128** and **130**. Since the shutters are of a flexible material, they tend to "balloon" or expand, as shown in FIG. *10b*, thereby shutting off light from the source **20** to the observer **18**. Again it should be noted that the electrically conductive coatings of the shutters **114** and **116** form an outer layer and the coatings of the shutters **128** and **130** form an inner layer.

Referring to FIGS. *11a* and *11b*, there is shown a light valve coupled to a biasing voltage source **136** (shown schematically as a battery) and to a control signal source **138** (shown as an alternating current source). In this embodiment, the housing **140** is of an electrically conductive material connected to ground and coated on the inner surface with an electrically insulating material **142**. An input panel **144** and an output panel **146** again form an enclosure which prevents external electrostatic forces from interfering with the operation of a pair of leaf shutters **148** and **150**. The leaf shutters **148** and **150**, when in an uncharged state, are positioned against an electrically conductive center plate **152** which is covered with a layer of electrically insulating material **154**. The center plate **152** connects to the voltage source **136** and the leaf shutters **148** and **150** are connected to the voltage source **138**.

The source **136** is designed to generate a voltage equal to the pull-in voltage, V_p, described previously. When the control signal **138** equals V_p, the shutters **148** and **150** will be pulled close to their respective walls as shown in FIG. *11b*. To return the shutters **148** and **150** to a light transmission position, the control signal **138** is lowered from the V_p level. Using a two

electrostatic field system, the shutters 148 and 150 will be pulled away from the walls before the control signal reaches ground potential because they are closer to the center plate 152 than to their respective walls. This narrowing of the control signal range means an improvement in the drive sensitivity. Also, the existence of two electrostatic fields enables the use of poor elastic materials for the shutters 148 and 150. Of course, including the panels 96 and 98 of the embodiment shown in FIGS. 9*a* and 9*b* or the hollow ports shown in FIGS. 7 and 8, will further enhance the response time of the valve shown in FIGS. 11*a* and 11*b*.

In general, the shutters of the various valve configuration shown are designed and oriented to minimize the effect of the earth's gravitational field or external magnetic fields by using nonmagnetic materials. Actually, the effect of the gravitational field on the shutters is equivalent to a fixed brightness bias, as discussed with respect to FIGS. 11*a* and 11*b*, and can be used to return the shutters to an initial position. It is also contemplated that a small permanent magnet may be positioned within the valve housing to return a magnetic shutter made from a material having poor elastic properties to an initial discharged position.

Because a leaf shutter is a mechanical member, it has low-pass mechanical filtering properties and for this reason may be used in applications where vibrations are encountered. This is an inherent advantage of a light valve fast enough to operate at the display frame rates discussed previously. Thus, the light valve of this invention is not restricted to stationary applications.

Many variations can be made in the number of leaf shutters per valve, the configuration and geometry of the shutters, and the number and arrangement of housing walls to produce many desired lighting effects. Referring again to FIGS. 5 and 6, a three color display can be generated with this valve by merely dividing the leaf shutter 50 into three equal segments and connecting each segment to a separate charging source. In effect, each of the valves 44, 46 and 48 would then be three valves, one for each of the three primary colors. The input and output panels would include filters to pass only the desired color.

Although several embodiments of the invention, together with modifications thereof, have been described in detail herein and shown in the accompanying drawings, it will be evident that various further modifications are possible in the arrangement and construction of its components without departing from the scope of the invention.

I claim:

1. An electromechanical light valve for controlling the transmission of light from a source comprising:
- a housing having grounded conductive walls for shielding the interior thereof from external electrostatic forces;
- mounting means in said housing transmitting light from said source and electrically insulating; and
- at least one electrostatically controlled leaf shutter mounted to said means and deflectable in said housing by means of an electrostatic charge thereon generated by an applied voltage.

2. An electromechanical light valve for controlling the transmission of light from a source as set forth in claim 1 wherein said mounting means includes curved surfaces against which said leaf shutter deflects thereby improving the response time of said shutter.

3. An electromechanical light valve for controlling the transmission of light from a source as set forth in claim 1 including means for charging said leaf shutters to a level slightly less than the pull-in voltage of said shutters.

4. An electromechanical light valve for controlling the transmission of light from a source as set forth in claim 1 including means for reducing the air drag on said leaf shutters.

5. An electromechanical light valve for controlling the transmission of light from a source as set forth in claim 1 including filter means at said housing to transmit to light waves having only preselected wavelengths.

6. An electromechanical light valve for controlling the transmission of light from a source comprising:
- a housing including means for shielding the interior thereof from external electrostatic forces;
- a first set of electrostatically controlled leaf shutters positioned at the inner walls of said housing and deflectable by means of an electrostatic charge thereon; and
- a second set of electrostatically controlled leaf shutters positioned at the center of said housing opposite said first set of shutters and deflectable by means of an electrostatic charge thereon generated from an applied voltage, said sets of electrostatically controlled shutters deflectable in a manner to impede the transmission of light through said housing.

7. Apparatus for controlling the transmission of light from a source in a continuously changing pattern comprising:
- a plurality of electromechanical light valves each including a housing having means for shielding the interior thereof from external electrostatic forces and at least one electrostatically controlled leaf shutter mounted to a panel at the light source end of said housing and deflectable in said housing by means of an electrostatic charge thereon;
- scanning means for connecting a voltage to said electrostatically controlled leaf shutters to generate the electrostatic charge thereon in accordance with a changing program; and
- an output panel covering said light valve housings at the end opposite from said source having a conductive inner surface connected to ground.

8. Apparatus for controlling the transmission of light from a source as set forth in claim 7 including means for receiving a video signal connected to said scanning means for programming the operation of said electromechanical light valves.

9. An electromechanical light valve for controlling the reflection of light from a source comprising:
- a housing including means for shielding the interior thereof from external electrostatic forces;
- means for piping light into the interior of said housing; and
- an electrostatically controlled leaf shutter mounted in said housing and deflectable by means of an electrostatic charge thereon, said leaf shutter blocking out light into said housing in a first position and reflecting light from said housing transmitted through said piping means in second position.

10. An electromechanical light valve for controlling the reflection of light from a source as set forth in claim 9 wherein said piping means includes an electrically conductive fiber optic panel for mounting said leaf shutter.

11. Apparatus for controlling the transmission of light from a source in a continuously changing pattern comprising:
- a plurality of electromechanical light valves each including:
  - a housing including means for shielding the interior thereof from external electrostatic forces;
  - a mounting frame forming a passage for transmitting light from said source to an observer; and
  - at least one electrostatically controlled leaf shutter mounted between said housing and said mounting frame and deflectable therein by means of an electrostatic charge thereon generated from an applied voltage.

12. An electromechanical light valve for controlling the transmission of light from a source as set forth in claim 11 wherein said housing is of an electrically conductive material and said leaf shutters are in electrical contact with said housing.

13. An electromechanical light valve for controlling the transmission of light from a source comprising:
- a housing including means for shielding the interior thereof from external electrostatic forces;
- a mounting frame forming a passage for transmitting light from said source to an observer; and

at least one electrostatically controlled leaf shutter mounted between said housing and said mounting frame and deflectable therein by means of an electrostatic charge thereon generated from an applied voltage; wherein said mounting frame is an electrically conductive material in electrical contact with said leaf shutters and wherein said housing is an electrically conductive material coated on the inner walls with an electrically insulating material.

14. An electromechanical light valve for controlling the transmission of light from a source as set forth in claim 13 including means for reducing the air drag between said leaf shutters and said electrically insulating coating.